FUNGICIDAL TREATMENTS FOR IMPROVING SUGARCANE STANDS

By A. McMARTIN.

In a previous paper[1] reference was made to the beneficial results which had been obtained experimentally by the application of fungicides to sugarcane cuttings prior to planting, especially where the disease known as Pineapple Disease was present.

Since then this technique has been the subject of further experimental work, and also is being given a trial by numerous growers.

This paper is a summary of the results that have been obtained from the inception of this work up to the present time.

The experiments to be described had their origin in the observation that cuttings treated with mercuric chloride grew much better than untreated cuttings, an observation made at the time when an investigation into the failure of cuttings to germinate had shown that such failure could be mainly attributed to the activities of micro-organisms. These latter attacked the cutting and, causing fermentation, not only deprived the buds of food material but produced toxic substances which had the effect of retarding growth, or perhaps inhibiting it entirely; further, the destructive power of these micro-organisms was more in evidence the more the environmental conditions deviated from the optimum for quick development of new organs from the cutting. Thus, under dry conditions, failure to grow was not due in the first instance to lack of moisture *per se*, but to the fact that the fungi and bacteria could develop more quickly than the buds and roots, and so suppress the latter. It has repeatedly been shown that if the former can be suppressed, there is sufficient moisture in a cutting itself to enable the latter to grow.

Hence the idea of applying fungicides at planting time to destroy or inhibit fungoid and bacterial growth, and to allow the buds and roots to develop normally.

The first experiment, in 1936, was designed to test whether such material was best applied to the cutting itself, or to the soil in the opened furrow, with the following results:—

	Germination percentage.	Weight of cane per plot (1/225 acre) in lbs.	
		Plant cane.	1st Ratoon
Applied to the soil—			
Formalin	38.5	420.5	424.2
Paradichlorbenzene	34.6	309.5	389.0
Cresylic acid	29.8	410.3	336.2
Cheshnut compound	29.5	316.5	349.5
Applied to the cutting—			
Agrosan	61.1**	465.5*	408.2
Ceresan	54.5**	529.0**	454.5*
Control	29.5	309.5	319.5

** Better than controls at 99 : 1 odds. * Better than controls at 19 : 1 odds.

The variety used was Co.301, planted on a sandy soil, in December, and the rainfall from planting time till the first sign of germination in the middle of January was 0.73 inches.

The two cutting treatments, Agrosan and Ceresan significantly improved germination and led to a greatly increased yield of cane.

Over the two crops Ceresan increased the yield by 56 per cent. and Agrosan by 39 per cent. The soil treatments were not statistically effectual, although formalin treatment showed some promise.

It was obvious, therefore, that under dry conditions great benefit could be obtained by treating cuttings prior to planting.

Another experiment was carried out in which the opposite environmental conditions were obtained, viz., those of waterlogging.

In this a comparison was made between applying Ceresan on the cutting and on the soil. Co.290 was planted, and after planting, 11 inches of rain fell in 18 days; the field was under water for some considerable time.

The following were the results:—

	Lbs. cane per plot (1/150 acre)
Ceresan on the cutting	544.4
Ceresan in the furrow	597.6
No Ceresan	563.5

These differences were too small to be statistically significant, but did suggest that under conditions of excess moisture Ceresan might have some toxic effect.

This possibility was made the object of a pot experiment in the glasshouse, in which different brands of organo-mercurial fungicides were tried under three levels of soil moisture—very dry, optimal, and waterlogged.

The following table shows the results expressed as a percentage germination of the buds planted:—

		Fungicide.			
Moisture.	Control.	Ceresan.	Agrosan.	Improved Agrosan.	Abavit.
Dry	46	92	78	70	75
Optimum	86	95	93	92	88
Wet	27	13	42	46	10

It is obvious from these figures that the control of moisture is an extremely important factor in obtaining a good germination. It is also obvious that under dry conditions fungicidal treatment is very effectual, and indeed can produce as good a germination as untreated cane under good moisture conditions. Under wet conditions, however, where germination is naturally very bad, some treatments decidedly did harm, whereas others were beneficial.

The next experiment was designed to compare once again the results obtained when Ceresan and Agrosan were applied to the cutting as against their application to the soil; and, further, their effect when mixed with fertilizer; it was carried out on Co.281, Co.290 and Co.301, on good soil under good conditions. No filling-in of blanks had to be done in the control plots.

This was done as a field experiment, the results of which are shown in the following (average of all varieties):—

	Germination percentage.	Tons sugar per acre. Plant cane.
Control	34.8	8.52
Fertilizer alone (800 lbs. mixed fertilizer)	36.2	8.77
Ceresan on the cutting	69.7**	10.53**
Ceresan on the cutting plus fertilizer	71.0**	11.19**
Ceresan in the furrow	33.2	7.57
Ceresan and fertilizer mixed, in the furrow, (old mixture)	36.2	9.41
Ceresan and fertilizer mixed, in the furrow (fresh mixture)	30.2	8.61
Agrosan on the cutting	72.5**	10.05*
Agrosan on the cutting plus fertilizer	68.0**	12.21**
Agrosan in the furrow	36.5	8.40
Agrosan and fertilizer mixed, in the furrow (old mixture)	33.3	8.96
Agrosan and fertilizer mixed, in the furrow (fresh mixture)	32.8	9.41

** Better than control at 99 : 1 odds. * Better than control at 19 : 1 odds.

It was thus obvious that, by increasing the population of young shoots, a marked increase in crop could be obtained. To produce this response, however, the fungicide had to be applied to the cutting.

The difficulty, however, in adopting this technique on any large scale was the method used at that time of applying the

fungicidal dust to the cutting. These fungicides were originally intended for treating seeds prior to sowing, by shaking the latter up in some container into which a little of the powder was introduced.

In these experiments described, the attempt was made to adapt this technique to sugarcane, by rocking the cuttings in drums into which the fungicide was placed, a very laborious procedure. A few growers did try it, and several reported very good results, but the method was too expensive to continue with.

An experiment was then conducted with a wet method, in which a 1 per cent. solution of Ceresan was made, and the cuttings soaked in it. This was found to improve considerably the germination percentage of the older buds on the stick, but to depress the rate of growth of the young shoots which emerged and to kill the young buds on the stick. This method was therefore not continued with at that time.

The next step in the investigation was the discovery that only the cut ends of the cutting required a protective coating of the fungicide, as was shown in the paper previously referred to. This experiment, with Co.331 infected with pineapple disease, and planted in a dry winter, gave the result which follows:—

	Percentage of buds grown.
Controls	9
Agrosan	22
Ceresan	24
Thiosan	17

This method greatly simplified the method of application, which was to pick up the cuttings in bundles and dip them, first one end and then the other, into buckets in the bottom of which a few inches of the powder were placed.

A comparative trial of a number of fungicides was planted this last planting season (1944), including two wet treatments, Verdasan and Aretan, both organo-mercurial compounds used as 0.5 per cent. solutions. In this experiment again only dipping the cut ends was carried out. The variety used was Co.331, known to harbour pineapple disease, and the experiment was planted in a sandy soil in August during a drought. The following results were obtained:—

Fungicide.	Number of buds grown out of 1,200.	Total number of shoots after 3 months.
Aretan	681**	3,205**
Agrosan	599**	1,856
Verdasan	707**	1,831
Ceresan	623**	1,831
Arasan	540**	1,603
Cuprocide	511*	1,555
Spergon	535**	1,512
Thiosan	517*	1,478
Nomersan	518*	1,388
Tulisan	498*	1,298
Vasco 4	383	1,291
Control	370	1,493

** Better than control at 99 : 1 odds. * Better than control at 19 : 1 odds.

Thus once again marked improvement in germination was obtained, and Aretan so stimulated the rate of development that much more vigorous tillering was produced.

This experiment is of particular interest, because it demonstrated that, despite the drought which was being experienced at that time, a good stand of cane could be procured by the use of a suitable preplanting fungicidal treatment. Planters generally were at that time waiting for rain, their planting programme being delayed. The opportunity was therefore taken of interesting a number of growers in giving this technique a trial on a larger scale than could be undertaken at the Experiment Station, and at the same time some experiments and demonstration plots on estates were planted.

At Doornkop, two earlier experiments with Co.331 and Co.301 respectively were planted; here planting was done in July, and the cuttings were treated by dipping in Ceresan powder. In one series the trash was removed, in another it was left on, while a third was untreated. Very impressive results were obtained by fungicial treatment, but the removal of trash made no difference in improving the stand. The untreated cane, and the cane with the trash removed, produced extremely gappy stands, while the Ceresan-treated plots showed few or no blanks.

In the same month a series of plots was started on a field at Central Factory, where an earlier planting had been a complete failure due to the ravages of pineapple disease, and had to be ploughed out. In this experiment a plot has been planted each month of untreated cane of the variety Co.331, together with plots of different brands of fungicides. In no month has the treated cane produced any blanks, whereas the untreated cane frequently has; moreover, counts of shoots have shown that even where the untreated cane produced an even stand, the best treatments produced double the number of young shoots.

Several growers have reported very favourable results, mainly by the use of Aretan, the fungicide which so far has been mostly used. Those growers especially who have been experiencing bad germination, and the number of these appear to be increasing in the last few years, agree that the filling-in of blanks can be reduced to a minimum by the dipping of the cuttings in a 0.5 per cent. solution of this material.

Even where conditions for germination have been good, and no disease has been present, improvement in the density and vigour of the young shoots has been brought about in some cases.

In others, again, no difference can be seen between treated and untreated cane; it may be that under these conditions a different fungicide would have given different results, or it may be that the conditions were such that fermentation of the cutting was delayed till such time that it would have no influence on the young plant.

Owing to the ease of applying a liquid fungicide compared with a powder, and to the much smaller quantity used even when compared with dipping the ends only of the cuttings in a powder, laboratory experiments were commenced with these fungicidal dusts stirred up in water.

It was found that the active ingredient was apparently sufficiently soluble to be effectual used thus, and a comparative trial of these materials, all used in solution only, was carried out in pots in the glasshouse. Again, three levels of soil moisture were maintained.

The following were the results, expressed as number of buds grown out of thirty:—

	Moisture.		
Fungicide.	Dry.	Optimum.	Wet.
Control	4	13	4
Ceresan 1 per cent.	21	27	13
Ceresan 2 per cent.	22	29	5
Agrosan 1 per cent.	12	27	14
Agrosan 2 per cent.	20	28	3
Abavit 1 per cent.	20	29	3
Abavit 2 per cent.	15	29	4
Aretan 0.5 per cent.	18	27	4
Aretan 1 per cent.	19	30	4
Verdasan 0.5 per cent.	13	27	12
Verdasan 1 per cent.	8	23	12
Tillantin 0.5 per cent.	1	13	5
Tillantin 1 per cent.	5	22	5
Spergon 0.5 per cent.	8	22	6
Spergon 1.2 per cent.	5	24	9
Spergon 2.5 per cent.	9	26	6

This experiment showed that under dry conditions germination was improved by Ceresan, Agrosan, Abavit and Aretan at both concentrations, and by Verdasan at 0.5 per cent.; under good conditions all treatments except the 0.5 per cent. Tillantin were beneficial, while under wet conditions Ceresan 1 per cent., Agro-

san 1 per cent. and Verdasan at both concentrations improved germination.

The main point which this experiment demonstrates is that there is a range of material which can produce beneficial results when used as solutions, although perhaps they were not intended to be used as such.

The different response produced by these materials under different conditions, however, indicates much more experimental field work before definite recommendations can be made on the best use to which any particular brand can be put.

This experiment has been followed by one in the field, in which again the fungicides have been used as liquid dips only. This was planted with Co.281 in January of this year, and received a good soaking rain after planting. The following are the results up to date, expressed as number of buds grown out of 1,200:—

Agrosan 1 per cent.	502
Agrosan 2 per cent.	530
Ceresan 1 per cent.	525
Ceresan 2 per cent.	521
Harvesan 2 per cent.	453
Harvesan 4 per cent.	473
Abavit 1 per cent.	601
Abavit 2 per cent.	554
Spergon 0.5 per cent.	346
Spergon 1.2 per cent.	424
Spergon 2.5 per cent.	451
Control	331

In this experiment some of the untreated plots are very gappy, a feature which is again reduced to a minimum by the best fungicidal treatments.

The most recent experiment is one planted on a field at Central Factory, in February, on good red land with Co.281, after rain; the object here was to ascertain whether treatment with Aretan would produce a response in final yield under conditions in which no filling-in of blanks would be experienced in untreated cane. Counts made so far have shown that the treatment has produced a 25 per cent. increase of young shoots, although the untreated cane has germinated evenly and well.

Sufficient examples have now been quoted to show that this technique is one well worth trying by planters; if every time a field is planted a fairly large plot of treated cane is put in, the grower would after some experience be able to assess for himself the value or otherwise of adopting such a practice; indeed a few, from experience gained this year, have already decided to adopt it on a larger scale for next season's planting.

Reference.

[1] McMartin, A. (1944): Pineapple Disease of Sugarcane Cuttings and its Control, Proc. S.A. Sugar Tech. Assoc., **18**, 44.

The PRESIDENT predicted that we here had the beginning of a new technique in sugarcane planting. Dr. McMartin had shewn the effect of a large number of fungicides on cane germination, but these were by no means the only fungicides. One planter recently used the locust poison calcium arsenate by mistake, and the results proved to be most beneficial.

Dr. FISHER said that the fact that fungicides now had to be resorted to in planting cane shewed the danger of monoculture which was responsible for large accumulation of fungi in the soil. Dairy farming with the requisite pasture would largely restore the virgin condition of the soil, and much better cane yields could be expected.

Dr. McMARTIN could not agree that the continuous cane growing could be responsible for germination defects. He pointed out that in Scotland where a most complete cycle of rotation was followed, 70 to 75 per cent. of the farmers treated their seeds with fungicides before sowing because they found that the treated seeds produced better crops.

Dr. DODDS said that with the introduction of water-soluble fungicides such as Aretan, the treatment of cane had reached a practical stage which would affect the whole economy of the sugar industry. The normal period of cane planting had been considerably extended enabling the farmer not only to plant when weather conditions were ideal, but when he wanted to.

Mr. CUTLER said Dr. McMartin had entered a very wide and fruitful field of investigation. The number of new fungicides was so large that the Department of Chemical Services at Pretoria had examined from four to a dozen new ones a day and it was quite possible that some of them might lend themselves to this specific use very well. This he considered only the beginning of a long series of trials which would take a long period to carry out.

Dr. McMARTIN in reply to a question said that he was frequently being asked whether the treatment of cuttings would lead to an economy in planting material. It was still too soon to give a reply, as only one experiment had been planted to elucidate this point: here, under good planting conditions, Aretan treatment had given an increase of young shoots of 25 per cent.; single stick planting treated with Aretan, had therefore not such a dense population of shoots as double stick planting without Aretan. It remained, however, to see what the difference in tonnage in the resulting crop would be.

Major ANDERSON said that after the rains began he planted twenty-four rows of cane treated with Aretan and the rest of the field without any treatment. The improvement in the Aretan-treated rows were most remarkable, and he expected that if planted during a drought the result would have been even more outstanding. He was nevertheless most satisfied and was at present filling in the gaps in some earlier planting with Aretan-treated cuttings.

Dr. McMARTIN in elucidating further on his paper said that lime was partly effective in increasing germination; in fact that was true of many things he had tried, but there was so far nothing that equalled the organo-mercurials or to some extent the sulphur compounds in effectiveness. These fungicides had also been tried in Mauritius and most favourable results had been reported.

Fungicidal treatment had not yet been tried under virgin soil conditions, but in one field where planting was done under very dry conditions 20 tons of compost made from stable manure proved of no assistance, and the only way germination was ensured was by fungicidal treatment.

Mr. STEWARD said the general impression was that Aretan was most effective under very dry conditions. That, however, was not his experience. They found Aretan of value in planting under drought conditions, but the most outstanding differences in favour of Aretan had been obtained in a waterlogged field.

Dr. McMARTIN said he had not tried Aretan in field experiments under waterlogged conditions, but in one case where it was tried under very wet conditions it did not assist germination.

Mr. ROBERTS said he had had considerable difficulty in getting a good stand of cane. In March he had almost completed his planting programme. When, however, Dr. Dodds told him about Aretan he immediately got some. Nine acres were planted single stick and treated with Aretan, and that now was the best stand of cane he had ever had.

Mr. Du TOIT asked what amounts of water were applied to the pots maintained under wet, optimum and dry conditions.

He thought there was some danger of drawing general conclusions from germination results only. From the table where both the number of buds grown out of 1,200 and the number of shoots after three months were given, it appeared that the number of shoots after three months was actually less in some cases than the controls although germination might have been improved significantly. Another point which emerged from this table was that only in the case of Aretan treatment was there a higher number of shoots formed per bud germinated.

Dr. McMARTIN in reply said that the water retaining capacity of air-dried soils was first determined and soils kept at 60 per cent. of the water retaining capacity was considered at optimum moisture, while the dry series only had 20 per cent. These pots were kept under these conditions by frequently weighing and

adding water lost through evaporation. The wet series constituted conditions of excess moisture or waterlogged soils. An interesting point that emerged was that treated cane in the dry series withstood a subsequent artificial drought much better than cane grown under optimum conditions. He agreed that germination did not necessarily reflect ultimate yields. In the first experiment Agrosan had a 61.1 per cent. germination and Ceresan only 54.5 per cent., and yet the subsequent crop from Ceresan was greater. This difference could be attributed to the fact that Agrosan had a retarding effect on the *rate* of germination, whereas Ceresan increased it; the difference in rate of germination was sufficiently great to influence the rate of tillering, so that when Agrosan-treated cane was still germinating, the Ceresan-treated cane was stooling out. There are thus two aspects of the response to these fungicides—their disinfectant value as measured by the germination percentage of buds grown, and their effect on the growth rate. It had been found further, that although increasing the germination also increased the yield, the best treatments were those which also increased the growth rate; hence the presentation of figures shewing the population at three months old, which show the treatments which not only have increased germination, but speeded it up. The increase in rate of germination might be explained by the fungicide in question having a stimulating effect apart from a disinfecting one, but to prove that true stimulation, in the sense of a tonic effect, existed, was a difficult matter.